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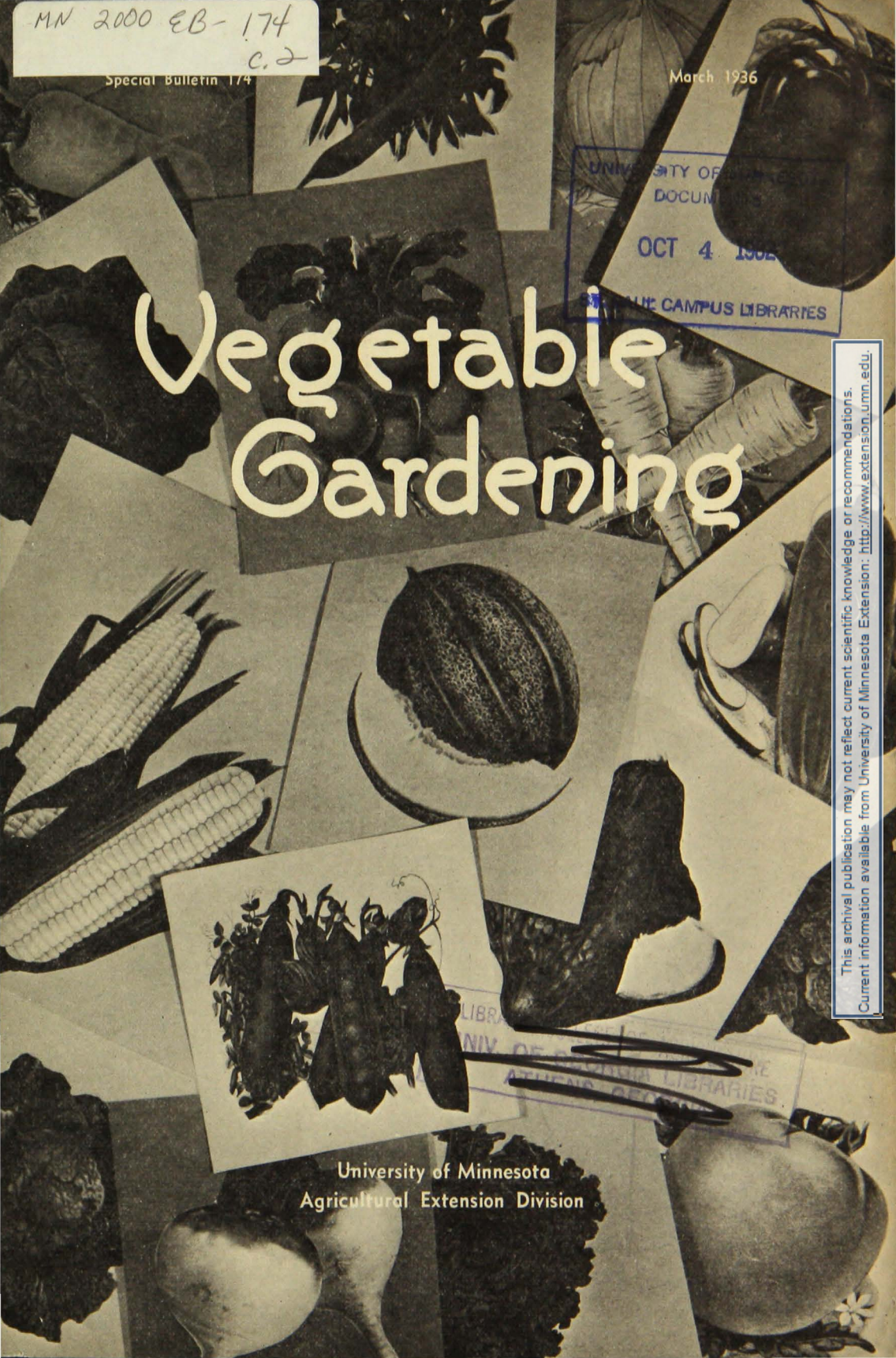
Vegetable Gardening



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VEGETABLE GARDENING

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With proper cultural attention, a garden of from one-half to three-quarters acre can be made to supply practically all the fresh, dried, canned, and stored vegetables required by a family of six. By extending its size somewhat and including some of the small fruits, its economic value can be still further increased. While a garden, in most cases, will not provide a farmer with a cash income, it will prevent the necessity for a considerable cash outlay.

THE SIZE AND LOCATION OF THE GARDEN

The size and location of the town garden is often fixed by the size and arrangement of the gardener's lot. Where the area is small, the volume and variety of vegetables produced may be increased by using certain methods of intensive culture.

The size of a large garden should be determined chiefly by the size of the family. If plenty of land is available, the labor may be cut down by making the rows long and spacing them far enough apart to allow for the use of horse-drawn implements. Under favorable growing conditions, the approximate row-lengths necessary to provide an average family of five with an adequate vegetable supply are given in Table 1.

The garden is often a spare-time project, and much of the work is done by the housewife. Many vegetables, also, are best when used soon after being gathered. For these reasons, the garden should be near the house. On the farm, it is often desirable to have a small garden near the house containing the crops necessary for table use during the growing season and a larger one in the field for the production of bulk crops for drying, canning, and storage. The latter may be worked into the regular farming operations. A south or southeast slope is desirable since the soil in such locations warms up earlier in the spring, thus allowing earlier planting with a consequent production of earlier crops. This is particularly important with the vine crops, with crops of which an early supply is desired, and with a few vegetables for which the growing season in the region is barely sufficient to mature the crop. The best soil is a deep, well-drained, sandy loam, with a moisture-retentive sub-soil, but other soils with proper treatment give good results. Well fertilized sandy soils that are well supplied with organic matter promote early production. Peat soils are well adapted to the growing of potatoes and most root and leaf crops, but not usually to the development of fruiting and warm-season crops. Soil depressions should be avoided since such places are likely to be visited by late spring and early fall frosts. Gardens should not be near large trees.

Table 1
Adequate Vegetable and Fruit Supply for Family of Five*
(Two Adults, Three Children)

Product	Per person	Per week	Per year	To produce
Vegetables	3 servings daily			½-¾ acre garden
Potatoes	6 oz. a day	14-20 lb.	850-1040 lb.	15-20 rows 200 ft., ¼ early potatoes
Tomatoes—child	1 a day	9	468-550	50-75 plants, ½ early variety
adult	3-4 a week			
Greens				
Spinach, chard	2 a week	3 lb.	156 lb.	30 ft. New Zealand 150 ft. Bloomsdale 30 ft. chard
Lettuce, cabbage	3 a week	5 lb.	275 lb.	50 ft. lettuce† 400 ft. cabbage† ½ early cabbage
Green peas, beans	2 a week	5 lb.	260 lb.	5 rows 200 ft. peas† 1½ rows 200 ft. gr. beans
Dry beans, peas	2 a week	1½ lb.	78 lb.	4-5 rows 200 ft. peas†, beans (dry)
Other vegetables	⅓ lb. a day	12 lb.	600 lb.	Carrots 250 ft. Corn† 3 rows 200 ft. Radishes† 20 ft. Beets† 200 ft. Onions 2½ rows 200 ft. Cucumbers 150 ft. Rutabagas 200 ft. Squash 25 hills Parsnips 100 ft.
Fruit—fresh,	2 servings			25 ft. rhubarb
canned,	⅔ lb. a day	21 lb.	1110 lb.	15 grape vines
or dried				200 strawberry plants 12 apple trees 15 plum trees 10 gooseberry bushes 10 currant bushes 100 raspberry plants

Vegetable supply is generous and adequate. The production data are only approximate as fertility of soil, weather, and management all affect production. Table also assumes that a sufficient supply of meat, eggs, dairy products, grain products, and sugars is available.

* Adapted from "Farm First for Family Food," Inez Hobart, Minnesota State Emergency Relief Administration.

†Do not plant all at once; successive plantings will extend crop throughout the season.

WHEN AND WHAT TO PLANT

Some vegetables should be planted as soon as the soil can be worked in the spring. Others are tender, and their planting dates are governed to a considerable extent by the average dates of the killing frosts in the locality.

Some vegetables do best in cool weather while others reach their most satisfactory development in hot weather. Table 2 divides the vegetable crops into groups according to the temperature and moisture conditions under which they attain most satisfactory development. It also suggests varieties for each crop.

In selecting the crops and varieties for the garden, adaptability should be considered. This can be readily determined by noting the varieties

recommended by local seed companies, consulting the list recommended annually by the State Horticultural Society, and making inquiries among the neighbors to determine what has given them the best results. By checking one against the other, a very judicious selection can be made. The likes and dislikes of the family should be considered, also, but not to the exclusion of variety. A large number of different crops will do much toward keeping up the health of the family, making the menu appetizing and attractive, and lessening the drudgery of the cook. Quality is important, also, but depends to a large extent upon the tastes of the individual and can be determined best by testing the best adapted varieties in the garden.

In the farm garden, vegetables that can be canned and stored should be produced in quantities large enough to provide most of the winter supply for the family.

In the small garden, bulk crops and crops which require wide spacing should be eliminated from consideration. Vine crops and potatoes require a lot of space and can usually be bought, at the proper time, to better advantage than they could be grown in such a garden. Include such crops as lettuce, parsley, chives, spinach, chard, peas, beans, and radish which are quick growing, require little space, and adapt themselves to intensive culture. Tomatoes should be grown; also enough beets, carrots, and onions for immediate use. A few plants of rhubarb, asparagus, horseradish, and the herbs take up little room.

Table 2

Classification of Vegetables According to Their Seasonal Requirements Together with Varieties of Each Crop Suggested for the Home Garden*

I. COOL SEASON CROPS

A. Crops that cannot endure hot weather but which reach edible maturity so quickly that they can be planted in the open ground early enough to attain full development before hot weather

1. Leaf Lettuce—Grand Rapids, Black Seeded Simpson
2. Cress—Garden or Upland. (Broad-Leaved, Pepper Grass)
3. Spinach—Long Standing Bloomsdale, Virginia Savoy, King of Denmark, Old Dominion
4. Mustard—Giant Southern Curled
5. Radish, Summer—Scarlet Globe, Saxa, White Icicle
   Winter—China Rose, Japanese White, Black Spanish
6. Turnips—Early White Milan, White Globe, Yellow Globe
7. Kohl-rabi—Early White or Purple Vienna
8. Rutabaga—American Purple Top
9. Peas, Early—Little Marvel, American Wonder, World's Record, Thomas Laxton, Gradus
   Late—Alderman, Telephone

B. Crops that cannot endure high temperatures and that have so long a season of growth that they usually must be transplanted in order to reach their optimum edible stage during cool weather

1. Crops maturing before the heat of summer
   a. Lettuce, Butterhead—Big Boston, May King

* System of Classification adapted from "Productive Vegetable Growing," J. W. Lloyd. 4th ed. J. B. Lippincott, Phila.

Table 2—Continued

Crisphead—New York or Wonderful
Cos—Paris White

b. Cabbage, Early—Golden Acre, Copenhagen Market, Viking Copenhagen
Mid-Season—Marion Market (Yellows Resistant), Early Jersey Wakefield, Late Copenhagen Market Strains
Chinese—Chihli, Pe Tsai

c. Cauliflower, Early—Early Snowball

2. Crops making their principal growth in the cool weather of autumn
   a. Cabbage, Late—Penn. State Ballhead, Danish Ballhead, Premium Flat Dutch, Wisconsin Hollander (Yellows Resistant)
   b. Cauliflower, Late—Erfurt, Dry Weather
   c. Broccoli—Italian Green Sprouting or Calabrese
   d. Brussels Sprouts—Long Island Improved, Perfection
   e. Celery, Early—Golden Self Blanching, Golden Plume, Michigan Golden (wilt-resistant)
   Late—Giant Pascal, Winter Queen
   f. Celeriac—Large Turnip Rooted, Erfurt

C. Long season vegetables requiring cool, moist conditions during early development but capable of withstanding considerable heat and dry weather after becoming well established
1. Beets—Early Wonder, Detroit Dark Red, Crosby Egyptian, Good For All
2. Carrots—Red Cored Chantenay, Danvers Half Long, Nantes, Perfection, Imperator
3. Parsnips—Hollow Crown, Guernsey, Sweet Marrow
4. Salsify—Sandwich Island, Long White French
5. Horseradish—Maliner Kren
6. Chard—Lucullus
7. Kale—Dwarf or Tall Curled Scotch
8. Spinach—New Zealand
9. Parsley—Moss Curled
10. Cress—Pepper Grass
11. Endive—Green or White Curled, Broad-Leaved Batavian
12. Onions—Yellow Globe, White Globe, Red Globe, Silverskin, Riverside Sweet Spanish (transplants in the North), Ebenezer (sets), Yellow Bermudas (transplants), White Welsh (perennial)
13. Leeks—American Flag
14. Garlic
15. Shallots
16. Chives
17. Potatoes, Early—Irish Cobbler, Early Ohio, Triumph, Warba
Main Crop—Green Mountain, Chippewa, Rural New Yorker, Katahdin, Burbank Russet
19. Asparagus—Mary or Martha Washington
20. Rhubarb—Macdonald Crimson, Victoria, Linnaeus, Ruby

II. WARM SEASON CROPS

A. Crops having a short enough growth period to enable them to perfect their products in temperate regions during warm weather and that can be sown in the field
1. Beans, String, Wax—Pencil Pod, Black Wax, Unrivalled Wax, Delicious Wax, Brittle Wax
Green—Bountiful, Extra Early Red Valentine, Giant Stringless Green Pod, Henderson's New Stringless, Tendergreen
Pole—Kentucky Wonder, Horticultural, Lazy Wife
Bush Lima—Burpee, Fordhook, Henderson
Pole Lima—King of the Garden
Dry Shell—Brown Swedish, Robust Pea, Great Northern

A. 2. Sweet Corn, Extra Early—Golden Gem, Spanish Gold
Early—Golden Bantam, Minhybrid 202, Minhybrid 203, Extra Early Golden Bantam
Mid-Season—Whipples Early Yellow, Minhybrid 201, Golden Cross Bantam, Early Golden, Golden Sunrise
Late—Stowells Evergreen, Country Gentleman, Golden Giant Evergreen
3. Pop Corn—Japanese Hulless
4. Okra—Dwarf Green, White Velvet, Mammoth Long Podded
5. Muskmelon—Golden Osage, Bender's Surprise, Sugar Rock, Golden Champlain

Table 2—Continued

6. Watermelon—Northern Sweet, Kleckley Sweet, Fordhook Early, Winter Queen
7. Cucumbers, Slicing—Arlington White Spine, Early Fortune, Improved Long Green, Davis Perfect
   Pickling—Boston Pickle, Snows Prolific, Harris Double Yield, Chicago Pickling
8. Squash, Summer—White Bush Scallop, Golden Summer Straightneck, Cocozelle, Vegetable Marrow
   Winter—Green Hubbard, Blue Hubbard, Delicious, Kitchenette, Buttercup, Table Queen, Sweet Potato, New Brighton Hubbard (Southern Minnesota)
9. Pumpkin—Winter Luxury, Small Sugar

B. Crops requiring so long a growing season that they will mature little, if any, crop in northern regions unless started under glass and then transplanted to the field when conditions become favorable

1. Tomatoes, Early—Red River, Earliana, Bonny Best
   Mid-Season—Break O'Day, John Baer
   Late—Stone, Ponderosa, Marglobe, Golden Queen (yellow)
2. Eggplant—Black Beauty, New York Spineless, New York Improved
3. Peppers, Early—Harris Earliest, Harris Early Giant
   Medium—Crimson Giant, Jersey Giant, Neapolitan
   Late—California Wonder
   Tomato—Sunnybrook
   Cayenne—Long Red, Small Red
4. Sweet Potato—Nancy Hall, Priestly

ARRANGEMENT OF THE CROPS

The arrangement of the various crops in the garden is given in part in the following outline:

1. Make rows long and straight. The long row is particularly applicable to the garden in which horse cultivation is to be utilized.

2. Place tall growing plants so that they will not shade sun-loving plants.

3. Place perennial crops together, at one side of the garden.

4. Group plants according to maturity. The grouping of short-season crops permits the area to be replanted easily to other crops, facilitates seasonal rotation of crops, or will allow the planting of a green manure crop every other year where organic material is deficient in the soil.

5. Plan for a succession of each crop, or, at least, for a large variety of crops, throughout the season.

6. Do not crowd the plants more than is necessary.

THE VEGETABLE PLANTING TABLE

The smallest given distance between plants, both in and between the rows, is the minimum that should be allowed for the various crops. If horse cultivation is utilized, the distance between the rows depends, also, on the machinery to be used. The amount of seed given is somewhat larger than is absolutely necessary, in order to allow for poor germination and other adverse conditions. Planting dates for the tender crops are governed to a large extent by the average date of the last spring and first fall frosts that are severe enough to kill the plants. This will vary in various sections and the planting dates must be made to fit local conditions. With the hardier crops, the date depends on the time that the soil becomes tillable in the spring. Thinning distance and number of days to mature from seed varies with the different varieties to some extent. The table will give a relative basis on which to work.

Table 3

Crop Features Which Can Be Utilized in the Arrangement and in the Conservation of Land in the Vegetable Garden

Crops Occupying the Ground All of the Growing Season

Perennial	Annual		
Asparagus	Beans, Pole, Snap	Okra	Pumpkins
Chives	" " Lima	Onions	Salsify
Horseradish	Chard, Swiss	Parsley	Squash, Winter
Onion, perennial	Cucumbers	Parsnip	Spinach, New Zealand
Rhubarb	Eggplant	Peppers	Tomatoes
	Muskmelon	Potatoes, Sweet	Watermelons
		" Irish Late	

Crops Occupying Ground Part of Season May Be Followed by Others

Beans, Bush	Carrots	Lettuce	Potatoes, Early
Beets	Corn, Early	Mustard	Radish
Cabbage	Kale	Onions, Green	Spinach
" Chinese	Kohl-rabi	Peas	Turnip, Spring
Cauliflower			Rutabaga "

Crops Which May Follow Others

Beans, Bush	Carrots	Lettuce	Rutabaga, Fall
Beets	Corn	Mustard	Spinach
Cabbage	Celery	Potatoes, Late	Turnips, Fall
" Chinese	Kale	Radish	

Crops Which May Be Utilized in Interplanting

Early, quick-maturing, narrow-spaced		Later, slower-growing, wider-spaced	
Beans, Bush	Onions, Sets	Broccoli	Pumpkins
Beets, Early	Peas, Early	Brussels Sprouts	Spinach, New Zealand
Carrots, Early	Radish	Corn	Tomatoes
Lettuce	Spinach	Cucumbers	Squash
Mustard		Muskmelons	Watermelons
		Cabbage	

Crops Which May Be Planted Together in the Same Row

Quick-germinating and maturing		Slower-germinating and maturing	
Lettuce, Leaf	Radish	Beets	Parsley
Mustard	Spinach	Chard	Parsnips
		Carrots	Salsify
		Leek	Onions, Seed
		Spinach, New Zealand	

Crops Which Can Be Cut More Than Once

Asparagus	Kale	Parsley	Spinach, New Zealand
Chard	Mustard	Rhubarb	Cress

Crops of Which Only a Few Plants Are Needed for Average Family

Asparagus	Parsley	Peppers	Herbs, Various
Chard	Horseradish	Rhubarb	

Crops Which Can Be Staked or Trellised

Beans, Pole, Snap	Muskmelon	Pumpkins	Tomatoes
" " Lima	Peas, Pole	Squash	Watermelons
Cucumber			

Sun-Loving Plants

Corn	Muskmelon	Pumpkins	Tomatoes
Cucumbers	Peppers	Squash	Watermelons
Eggplant			

Table 4
Vegetable Planting Table
(Latitude of St. Paul)

Crop	Per 100-foot row		Distance apart in inches			Depth to plant in inches		Approximate Planting Date			Ready for use, days from seed	Approximate length of seed viability, years
	Seed to plant	Number plants thinned or transplanted	Horse cultivated rows	Hand cultivated rows	Plants in the row	Field	Under glass	In the open field (seed)	In the seed-box, hotbed or greenhouse (seed)	Transplant to the field		
Asparagus Plants	.....	50-66	36-48	36-48	18-24	6-9	..	.....	.....	April 15	2-3 (yrs.)	3
Beans, Bush	½ lb.	300-400	30-36	18-24	3-4	1-1½	¾	May 15§	.....	.....	50-70	3
" " Lima	½ lb.	150-200	30-36	18-30	6-8	1-2	¾	May 15	.....	.....	60-80	3
" Pole	½ lb.	35‡	36-48	36	36-48	1-2	¾	May 15	.....	.....	50-80	3
Beets	1 oz.	300-400	24-36	12-18	3-4	1	¼	April 15-July 1§	.....	.....	60-100	4
Broccoli*	1 pkt.	50	36	24-30	24	....	¼	.....	March 1	April 15	112-130	4
Brussels Sprouts*	1 pkt.	50-66	36	24-30	18-24	....	¼	.....	March 1	April 15	90-120	4
Cabbage, Early*	1 pkt.	66	24-36	24-30	18	....	¼	.....	March 1	April 15	90-120	4
" Late*	1 pkt.	40-50	36-42	24-30	24-30	....	¼	May 1 (or seed bed)	.....	June 1	90-130	4
Carrots	½ oz.	400-600	24-30	12-18	2-3	½	..	April 15§	.....	.....	60-100	2
Cauliflower*	1 pkt.	50-66	36-42	24-30	18-24	....	¼	.....	March 1	April 15	100-130	4
Celeriac*	1 pkt.	200	30-36	18-24	6	....	⅛	.....	March 1	May 15	100-130	3
Celery*	1 pkt.	150-300	36-48	18-24	4-8	....	⅛	.....	Feb. 15	May 15	110-140	3
Chard, Swiss	½ oz.	150-200	24-36	18-24	6-8	1	..	May 1	.....	.....	55-100	4
Corn, Sweet	¼ lb.	33-66‡	36-42	24-30	18-36	1-2	..	May 1	.....	.....	65-100	2
Cucumber	¼ oz.	20-25‡	48-60	36-60	48-72	1-2	½	May 15	.....	.....	60-100	5
Eggplant*	1 pkt.	50-66	30-36	24-30	18-24	....	¼	.....	March 15	June 1	140-170	5
Endive*	1 pkt.	100	24-30	18	8-12	½-1	¼	April 15	.....	.....	70-100	3
Horseradish roots	.....	66-100	30-36	24-30	12-18	....	..	.....	.....	April 15	1-2 (yrs.)	..
Kale	¼ oz.	50-100	24-30	18-24	12-24	½	..	April 15-July 15§	.....	.....	90-100	4
Kohl-rabi†	¼ oz.	100-200	24-30	18-24	6-12	½	¼	April 15-August 1§	March 15	April 15	60-80	4
Leek	½ oz.	150-300	24-30	12-18	4-8	1	..	April 15	.....	.....	80-120	1-2
Lettuce, Leaf	¼ oz.	150-300	24-30	12-18	4-8	½	¼	April 15§	.....	.....	40-50	5
" Head*	1 pkt.	100	24-30	18-24	12	....	¼	.....	March 1	April 15	100-150	5

Table 4—Continued

Crop	Per 100-foot row		Distance apart in inches			Depth to plant in inches		Approximate Planting Date				
	Seed to plant	Number plants thinned or transplanted	Horse cultivated rows	Hand cultivated rows	Plants in the row	Field	Under glass	In the open field (seed)	In the seed-box, hotbed or greenhouse (seed)	Transplant to the field	Ready for use, days from seed	Approximate length of seed viability, years
Muskmelon	¼ oz.	20‡	48-60	48-60	60-72	1-2	½	May 15	April 20	June 1	100-140	5
Onion, Seed	½ oz.	400-600	24-30	12-18	2-3	½-1	..	April 15	Feb. 15	April 15	120-150	1-2
" Sets	2 qts.	400-600	24-30	12-18	2-3	2-3	..	.....	.....	April 15	50-100	..
" Transplants	¼ oz.	400	24-36	12-18	2-3	....	¼	.....	Feb. 15	April 15	130-180	1-2
Parsley	¼ oz.	200-400	24-30	12-18	3-6	⅛	¼	April 15	March 15	May 15	90-120	1
Parsnips	½ oz.	200-400	30-36	18-24	3-6	½-1	..	April 15	.....	.....	125-160	1
Peas	1 lb.	400-600	30-36	24	2-3	1-2	..	April 15§	.....	.....	60-100	2
Peppers*	1 pkt.	50-66	30-36	18-24	....	¼	¼	.....	March 15	June 1	100-160	2
Potato, Irish	8-10 lb.	66-100‡	30-36	24-26	12-18	4-6	..	April 15-June 1	.....	.....	80-150	..
" Sweet (Plants)	.....	65-75‡	36-48	36-48	12-18	3-4	..	.....	April 15 (roots)	June 1	140-150	..
Pumpkin	½ oz.	11-14‡	96-144	96-144	84-108	1-2	½	May 15	.....	.....	85-120	4
Radish, Summer	¾ oz.	600-800	24-36	12-18	1½-2	½-1	..	April 15§	.....	.....	30-65	4
Rhubarb Plants	.....	33	36-60	36-60	36-60	2-3	..	.....	.....	April 15	1-2 yrs.	..
Rutabaga	¼ oz.	150-200	30-36	18-24	6-8	½-1	..	April 15-July 1§	.....	.....	70-110	4
Salsify	1 oz.	200-400	30-36	18-24	2-3	½-1	..	April 15	.....	.....	120-180	1
Spinach	¾ oz.	300-400	30-36	12-18	3-4	1	..	April 15§	.....	.....	45-70	4
" New Zealand	1 oz.	66-100	30-36	30-36	12-18	1	..	May 1	.....	.....	60-150	4
Squash, Summer	½ oz.	25-33‡	36-48	36-48	36-48	1-2	½	May 15	.....	.....	60-80	4
" Winter	¾ oz.	15-20‡	84-108	84-108	84	1-2	½	May 15	.....	.....	120-140	4
Tomatoes*	1 pkt.	25-35	36-60	36-48	36-48	....	¼	.....	March 15	June 1	120-160	5
Turnips	½ oz.	300-400	24-36	18-24	3-4	¼-½	..	April 15-July 1§	.....	.....	60-80	4
Watermelon	½ oz.	11-14‡	96-144	96-144	84-108	1-2	½	May 15	.....	.....	100-140	5

* Transplanted in this region. † Early crop often transplanted. Late crop sown in the field. ‡ Grown in hills. §Crops which may be used in succession planting or which may be used as both spring and fall crops.

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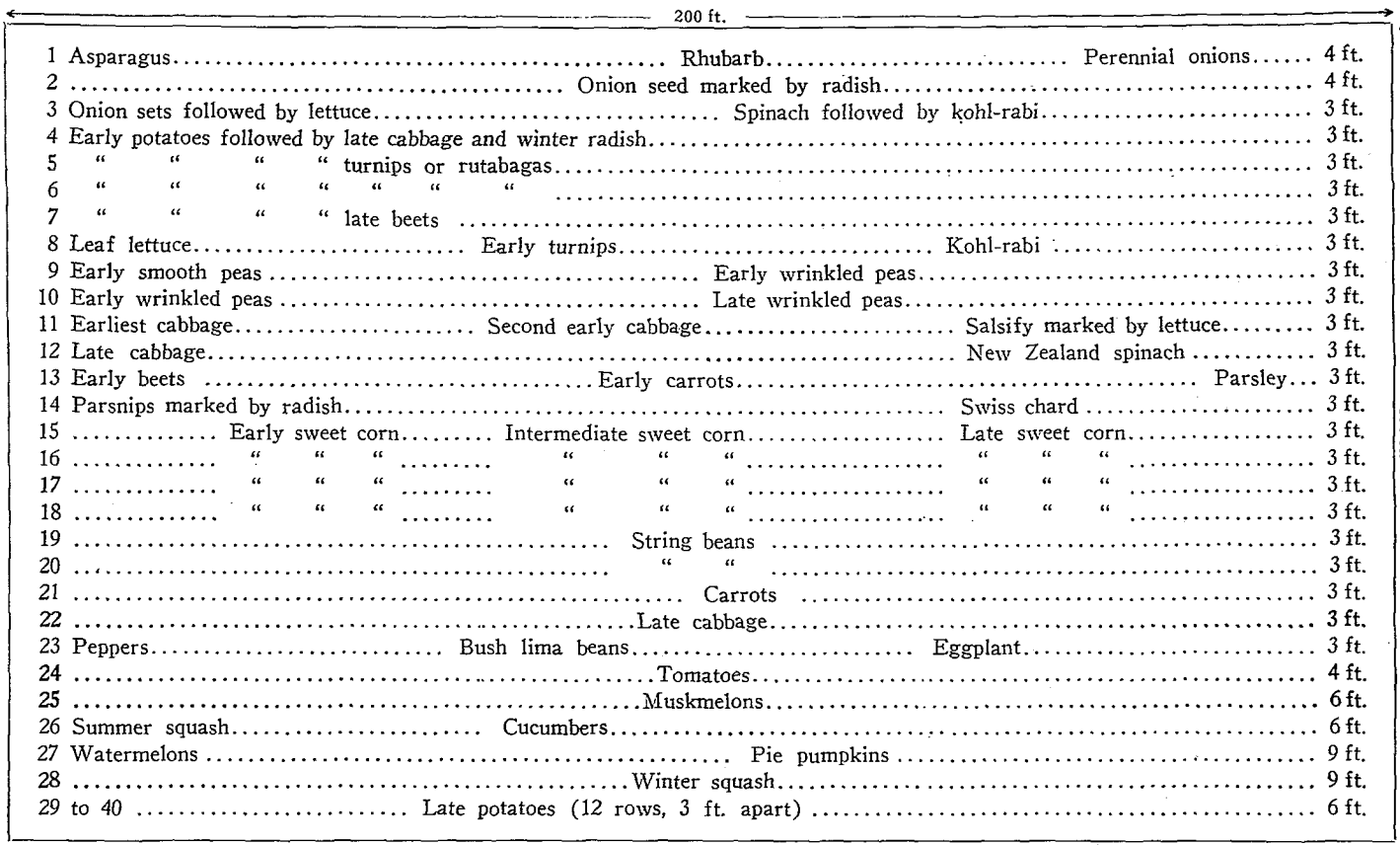

Fig. 1. Suggestions for the Long-Row Vegetable Garden

Such a garden, under fair growing conditions, should supply a family of six with sufficient vegetables for consumption during the growing season and for canning, pickling, drying, and storage. (The figures on the left indicate the rows, and those on the right, the distance between the rows. Position of the crop name on the plan indicates roughly the proportion of the row that should be occupied by the crop.)

THE GARDEN PLAN

The long winter evenings provide an ideal time for garden planning. It is well to take a pencil and ruler and draw a plan on paper. This can be merely a rough sketch, but it should show fairly accurately the crops, varieties, arrangement, spacing and other things that will facilitate operations in the spring. Such a plan will save a lot of time, energy, and worry at planting time and will aid one in producing an efficient garden that will utilize the land to the best advantage.

Through the growing season, make notations as to the results obtained and any modifications that may suggest themselves. If the plan and notes are preserved each year, the gardener can improve succeeding plans and add to his store of information. The following plans give suggestions as to large or farm gardens, smaller vegetable gardens, and combined flower, fruit, and vegetable gardens.

GROWING EARLY PLANTS

Certain vegetable crops in this region should be started before the time of field planting, because the growing season is not long enough to obtain satisfactory yields from them, because an early crop is desirable, or because they grow better in cool than in hot weather. When the weather and soil conditions become favorable, the plants are transplanted to the field. These plants may be obtained in several ways.

If there is a local grower in the community who makes a business of growing such plants, it is usually best to obtain them from him.

If there is no such dealer in one's vicinity, some kind of a cooperative agreement may be entered into, whereby one individual will grow plants for a whole neighbodhood. If the cooperating group is large enough, the grower can afford to install and maintain permanent hotbeds in which he can segregate the various crops under conditions which best meet their requirements for proper development. He can also afford to give them much more attention and care.

If neither of these methods is available, the gardener must grow his own. If only a small number of plants is required, they may be started in a small flat or window box. This should be about 3 or 4 inches deep, and of a size which is convenient to handle or to fit the individual's conditions. About one inch of gravel or coarse material should be placed in the bottom of the box to insure drainage, the remainder nearly filled with soil, the seed sown, and the box placed in a warm place in the light. When the plants are from one to two inches tall, they should be transplanted into other boxes, about two inches apart, or into individual containers. Old cans which accumulate about the house may be used for this purpose.

If larger quantities of plants are required, some form of hotbed or coldframe is very desirable. The permanent hotbed consists of the pit, manure, frame, soil and sash. In this type, the heating material is put in a pit and covered by a layer of soil, over which is placed the frame and the sash. A temporary hotbed does not have any pit to hold the heating material. In this type, the heating material is placed in a pile on the ground, and on top of this the soil, frame and sash are placed, as in the case of the permanent type.

A hotbed should be in an open, sunny position on the south side of a windbreak, wall, or close board fence, and, preferably, should slope to the south or southwest. If possible, protection should be provided on the western side also.

Hotbeds are usually made up between March 1 and April 1, the time depending on the locality and the plants grown.

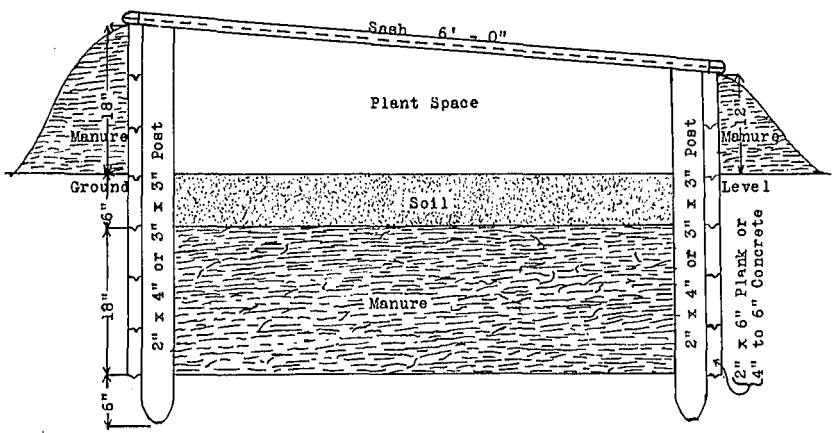

Fig. 2. Permanent Hotbed

A well-drained piece of land should be chosen. A pit about two feet deep for holding the heating material should be dug in the previous autumn. The sides and ends of the pit should be lined with 2-inch planks, or, if preferred, with brick or concrete. Some pits are made exactly the same size as the frame; some are made two feet longer and wider than the frame so that the heating material may project one foot beyond the outside of the frame.

A mixture of fresh horse manure, two parts, and short straw or chaff, one part, is one of the best materials for heating a hotbed. Manure from grainfed animals is preferred, as it is likely to undergo more active fermentation. If the manure contains too much straw, the generation of heat will be too slow to give the desired temperature. On the other hand, if there is no straw in the manure, it will heat too

violently, and the heating period will not last long. Place the manure in a flat-topped pile, four or five feet deep. When the pile has started to heat, turn it over. In two days turn it back again. After it has heated the second time it is ready for use.

Place the manure in the pit with a fork, a layer at a time, and tramp each layer firmly. Have the center of the manure slightly higher than the outer edges to allow for settling. Pour two pails of hot water evenly over the surface, and, as soon as the manure commences to heat again, cover with about two inches of straw. This helps to distribute the heat evenly. Bank the frame with manure up to the top on the outside.

Make the north side at least six inches higher than the south side. The average hotbed frame is slightly less than six feet wide, 18 to 20 inches high on one side, 12 to 14 inches on the other side. It may be as long as desired, in units of three feet, as the sash are 3 feet wide by 6 feet long. Use strong planks 2 inches thick in constructing the frame. The corners should be tight-fitting and strongly fastened together by dovetailing or with spikes driven into a 2x4-inch corner piece. A two-sash frame, 6x6 feet, is large enough to grow plenty of plants for most farm homes.

Storm windows are sometimes used in place of the regular hotbed sashes, but they are not so satisfactory. If these are used, the width of the frame will have to be made to suit the length of the window.

A rich, loamy soil, mixed with about one-quarter of its bulk of sand, is very satisfactory for hotbeds. This should be prepared the previous autumn, and placed where it will be easily accessible. The soil should be from five to six inches deep over the manure. When the soil has been placed in the frames, the sashes should be put on and the bed allowed to heat. Very high temperatures will probably be produced during the first two or three days. One should have a metal thermometer to thrust into the soil to determine the temperature. In a few days the temperature will have dropped to between 80 and 90 degrees F. The surface of the soil should then be raked and leveled and any weeds that have come up removed. The bed is then ready for sowing.

After a hotbed is planted, it requires careful, daily supervision to make sure that it does not become too hot or too cold. On bright, sunny days, the upper end of the sash should be raised slightly to allow enough ventilation to keep the temperature down to about 65° F. In cold, cloudy weather, the sash should be kept closed, and, if necessary, should be covered with heavy blankets, mats, or straw.

Coldframes, like hotbeds, are used to lengthen the growing season of plants. The general principles of their construction are exactly the same in all details as the hotbeds, excepting that no heat is supplied and manure pits are unnecessary.

Cold frames are used chiefly to start vegetables or ornamental plants late in the spring, in time for planting directly in the open garden, and to "harden off" plants grown in hotbeds or greenhouses.

Many commercial growers are using electricity, particularly in areas where manure is scarce, to replace manure as the heating element in hotbeds.

Plants of tender, long-season crops and of crops of which it is desirable to have an early supply are commonly started early in the spring in sunny windows or hotbeds so that they will be well advanced when conditions become favorable for field planting. Good plants for transplanting should be short and stocky, hardy, and have a well developed root system. Such plants can be obtained only by giving them plenty of room and by maintaining proper air, temperature, and moisture about them during their early growth.

Sow the seed fairly shallow in a good garden soil which can be made light and friable by the addition of leaf mold (decayed leaves) and sand if necessary. A mixture composed of 3 parts of garden loam, 2 parts of screened leaf mold or peat, and one part of sand, put through a one-quarter inch screen will usually serve the purpose. Level and firm the soil well in the flat or seed box. Make furrows about ¼ inch deep and 1½ inches to 2 inches apart, put 5 to 10 seeds per inch in the furrows, cover lightly with soil, and firm the soil over them. Water thoroly but slowly to prevent washing and cover the seed boxes with paper or glass until growth starts.

Tomatoes, peppers, eggplants, okra, vine crops (if they are to be transplanted), and early celery give the best results if kept, as nearly as possible, at a temperature of 55° to 60° F. at night and 75° F. during the day. Cabbage, broccoli, Brussels sprouts, cauliflower, kohl-rabi, head lettuce, and onions (where transplants are to be used) require about 45° F. at night and 60° F. during the day.

As soon as the first true leaves appear, the seedlings should be transplanted about 2 inches apart in other flats. This is all the transplanting required for such crops as cabbage, broccoli, Brussels sprouts, cauliflower, kohl-rabi, and celery, until they are put in the field. Eggplants, peppers, and tomatoes should be transplanted again into pots or cans 3 to 4 inches in diameter or into the hotbed or coldframe 3 to 4 inches apart to obtain the best results.

In the production of early plants of the vine crops, beans, and other similar vegetables, it is sometimes desirable to start the plants in berry boxes or cans, growing enough plants in each container for one hill in the field. These crops are difficult to transplant by ordinary methods.

When the soil becomes warm and weather conditions are favorable, the contents of the containers are transferred to the permanent field location, with as little disturbance of the soil about the roots as possible.

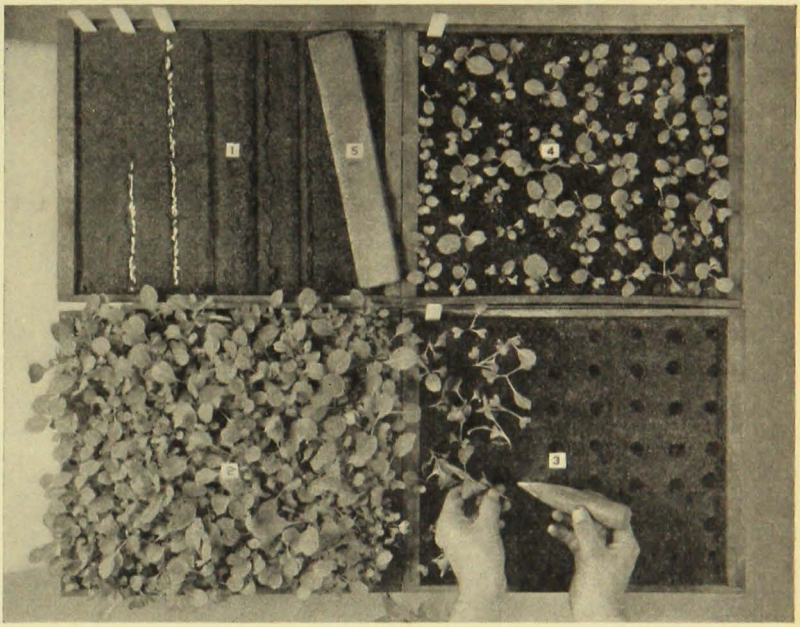

Fig. 3. Sowing and Transplanting in Flats
1. Sowing seed. 2. Flat of cabbage ready for transplanting. 3. Transplanting with dibble. 4. Transplanted flat of cabbage. 5. Marking board.

SEED FOR THE GARDEN

To be good, seed should be:

1. Clean—free from weed seed, dirt, and other foreign matter.

2. Viable—capable of a high percentage of germination and of the production of vigorous seedlings. Much of the seed put out by the best seed companies, at the present time, is tested and labeled with the per cent germination.

3. Free from disease. Certain diseases are seed borne, and one should obtain seed which has been treated for such diseases, where treatment is possible, or else be able to treat them himself before planting.

4. True to name. Most varieties put out by the better seed companies are fairly true to name or type. However, there is some variation and only by growing the plants can one determine whether there is enough variation to make it desirable to obtain the seed from some other source for the next planting.

Seed should be ordered early. New catalogs are usually available in January. Buy only seed that has been put out by reliable seed com-

panies. It is usually best to obtain seed sold by companies located in the general region of the grower, unless one knows that some company makes a specialty of a particular vegetable or that some desirable variety, not handled by local concerns, is adapted to the region, or unless one desires to experiment with new varieties or novelties. It is poor economy to buy seeds merely because they are cheap. The seed necessary for the garden is a small item in the total expense and good seeds give much better results. Poor seed is really the most expensive in the long run. Seed in small packets, handled by the local stores, if put out by the better companies, is just as good as bulk seed but is usually more expensive, and a greater selection of varieties can often be made by ordering through the catalogs.

Seed of crops which are self-fertilized, such as beans, Lima beans, peas, lettuce, tomatoes, and eggplants, do not cross, to any great extent, and can be saved by the gardener with a fair degree of success. Cross-pollinated vegetables, such as vine crops, members of the cabbage family, members of the onion family, beets, spinach, radish, carrots, celery, and parsnips, must be isolated a considerable distance from other varieties of the same crops, or varietal crosses are likely to spoil the variety completely.

PREPARATION OF THE SOIL

A sandy loam that is fertile, well drained, but retentive of moisture, and that is well supplied with organic matter is best, but most soil types will produce a good crop if given proper cultural attention.

Heavy soils and sod lands should be plowed or spaded in the fall. Light soils need not be plowed until spring. Turn the soil over to a depth of from 6 to 9 inches. If it is plowed in the fall, leave the soil in a rough condition until spring. Manure at the rate of 20 to 25 tons per acre should usually be applied before plowing. If the manure is applied on plowed land, it should be well rotted and disked into the soil before the seed is planted.

Where manure is scarce or very expensive, commercial fertilizers may be used, either to supplement manure or to take its place entirely. If no manure is used, organic matter must be added eventually in some other form, such as green manures. The composition of mixed fertilizers is expressed by such formulae as 4-8-6, 0-9-27, etc. The first figure stands for the percentage of nitrogen, the second for the percentage of available phosphate (expressed as phosphoric acid), and the third for potash. Thus, an 0-9-27 fertilizer contains no nitrogen, 9 per cent phosphate, and 27 per cent potash. A 4-8-6 mixture, applied at the rate of 500 to 1,000 pounds per acre will usually give good results on mineral soils if there is plenty of humus in the soil. On peat, 0-9-27 fertilizer

for root crops and potatoes, or 0-10-24 mixture for most other vegetables, is generally recommended. The fertilizer may be broadcast or applied in or beside the row. Care should be taken to mix the fertilizer thoroly with the soil and to keep it from direct contact with the seed or plants. Top dressing, after the plants are up, often aids in hastening growth and maturity.

Do not work the soil in the spring when it is too wet. Soil which forms a compact muddy mass when compressed in the hand and does not crumble readily when released often becomes lumpy, hard, and compact when worked, and loses much of its potential productivity. This is especially true of the heavier soils.

A deep, smooth, thoroly pulverized seed bed is very important. Seeds planted in coarse lumpy ground are apt to be unevenly covered and so germinate poorly and often do not grow well after germination. In smaller gardens, a satisfactory seed bed can be prepared with the garden rake. Where larger implements can be used, the ground should be thoroly disked, and then harrowed and dragged. A plank drag or a meeker harrow is an ideal tool for giving the final leveling and smoothing touches to the seed bed just before planting.

Improving Garden Soils

The texture and drainage of heavy clay soils can often be improved in the small garden by the addition of a few loads of sand or sifted ashes. Coal ashes have little or no fertilizer value; hard wood ashes have some potash and a little lime and have a small fertilizer value. However, only small quantities should be applied to the garden plot and they should be thoroly pulverized and worked into the soil. Surface ditches may be used to carry off excess water. In some cases tile drains may be necessary. In most home gardens, however, the drainage problem is not very acute.

Mineral soils should be rich in organic matter. This improves aeration and drainage, makes the soil mellower or more friable, aids in water retention, adds some fertility, and promotes the growth of soil organisms. It may be added in the form of stable manure, straw, artificial manure, decayed leaves, or green manures. Peat is also being used to a limited extent for this purpose.

Where animal manure is scarce, green manure may be substituted to some extent. Where plenty of space is available, it is a good practice to rotate the garden every few years with a green manure crop. Leguminous crops such as clovers, alfalfa, or sweet clovers are very desirable under such conditions. They not only add organic matter but increase the available nitrogen supply in the soil. Where space is limited, cow-

peas or soybeans may be sown, following the early vegetables, and plowed under the same fall. Rye is often used as a fall crop for this purpose. It can be sown rather late in the fall and will make a quick enough early growth in the spring to produce a considerable amount of organic matter by planting time.

Lime—in the form of ground limestone, usually—improves the texture of certain heavy soils, and aids in correcting soil acidity and in the development of beneficial soil organisms. But it should be used judiciously for many vegetables make their best growth on slightly acid soils. It should not be applied immediately preceding potatoes, as scab is apt to be much worse on limed soils. Some successful gardeners apply one ton of ground limestone to the acre every three years. The lime should be applied preceding legumes as they do best in a well-limed soil.

Irrigation and Mulching

Vegetables require plenty of water for best development, and irrigation is often of distinct advantage. Information on methods of irrigating gardens is given in Minnesota Extension Circular 47, obtainable from the Bulletin Office, University Farm, St. Paul. The same office can supply copies of Bulletin 298 on Mulch Paper in Vegetable Production.

SOWING AND TRANSPLANTING IN THE FIELD

Sow seed in straight rows in a thoroly prepared seed bed as soon as possible after its preparation. Sow seed thick enough to assure a good stand but do not allow plants to become overcrowded in the row. Small seed should be planted shallower than large seed. A rule often followed is to plant at a depth of 3 or 4 times the diameter of the seed. Seed should also be planted shallower in heavy moist soils than in sandy or lighter ones. It is well to firm the soil to some extent over the seed providing the soil is not too wet. Do not sow the seed in ground that is very wet or extremely dry.

In dry weather, it is often advisable to plant the seed a little deeper than usual, to get them into moist soil. This is particularly true of the larger seed such as those of the vine crops, beans, peas, corn, etc. Trenching below the dry surface soil and planting the seed at the bottom of the trench aids in germination. Plant as soon as the trench is opened, and cover the seed at the bottom of the trench with soil to the depth you would plant them under ordinary conditions.

Tomatoes, cabbage and related crops, peppers, eggplants, celery, cauliflower, and head lettuce are usually transplanted in Minnesota and present no very great difficulty. Onions are also easily transplanted.

Melons, cucumbers, squash, and beans are sometimes transplanted, but require special treatment for success. Enough seeds for a hill are planted in pots, berry baskets, or inverted squares of sod, allowed to grow about four weeks, and then transplanted to the field with as little disturbance of the root systems as possible. Sweet corn is sometimes handled in the same manner. Certain precautions should be taken in transplanting:

1. Transplant in cool cloudy weather or in the afternoon, if practical.
2. Harden the plants to some extent by exposing to outdoor conditions during the day, in good weather, for several days before transplanting, or by decreasing the amount of water given them to the minimum necessary to keep them from wilting.
3. Water plants well before disturbing.
4. If possible, keep a ball of dirt about the roots or dip them in muddy water until the plants are set in the field. Do not allow them to dry out. Injure the root system as little as possible.
5. Water soil before and after setting the plant. If soil is very dry, the hole should be partly filled with water before setting the plant.
6. Pack the soil firmly around the roots after setting.
7. If possible, shade the plants from the direct rays of the sun for a few days after transplanting, to give them a quicker and better start.
8. In hot dry weather, remove a part of the foliage to avoid excessive moisture loss.

THINNING AND CULTIVATION

Crowding tends to make plants weak, spindly, and poorly developed. In thinning, discard the weakest plants and leave the strongest and most healthy. Thin to a uniform stand as soon as there is reasonable assurance that the plants that are left will not be killed by unfavorable weather conditions or by insects and diseases. For thinning distances consult the planting table. In the home garden, particularly, a judicious thinning procedure enables one to obtain onions, carrots, and beets from the removed plants for table use for several weeks, and still leaves the plants thinned to the proper distance for their growth for storage. When thinning becomes necessary, remove the largest, wherever practical, for table use, being careful, however, not to let the remaining plants become too crowded.

Cultivation is primarily for the destruction of weeds which compete with the vegetable plants for moisture, soil nutrients, light, and air. Incidentally a soil mulch is maintained, the soil is better aerated, and the growth of beneficial soil organisms is promoted.

Cultivate early. See that the seed bed is free from growing weeds before planting. Stirring the soil surface thoroly with the garden rake does as much to eliminate weeds when they are small as does more costly cultivation later on. Frequent, shallow cultivation, when the

weeds are young, kills the weeds and produces a minimum amount of injury on the tender root systems of the vegetables. Cultivating or stirring the soil after each rain puts the ground in shape to receive the next rain and prevents baking and cracking. Do not cultivate heavy soils when they are so wet as to be sticky. If a crust forms over the soil surface before the seedlings come up, it may be advisable to break it by cultivating the surface lightly with a rake to permit the seedlings to emerge.

Cultivation in a garden of 1,000 square feet or less can be done easily with a garden rake and hoe. For gardens of 1,000 to 10,000 square feet, the wheel hoe is very desirable. For larger gardens, a one-horse cultivator equipped with small shovels to prevent excessive ridging is very satisfactory. Garden tractors with cultivator attachments are used to a considerable extent where horse power is not available. The large farm garden should be so arranged that the regular farm equipment can be utilized as much as possible.

HARVESTING

Some vegetables should be harvested long before maturity, others a short time before maturity, and others when they are fully matured. Quality is an important characteristic. Such crops as peas, string beans, Lima beans, sweet corn, broccoli, asparagus, and cauliflower deteriorate very rapidly, if not harvested soon after reaching edible maturity. Peas and Lima beans should be harvested as soon as the pods are well filled. String beans should be harvested before the strings become tough. Sweet corn has the highest quality as soon as the kernels are fully filled out. Broccoli should be used before any of the flowers open. Cauliflower "curds" should be smooth, white, compact and about 4 to 7 inches in diameter, when harvested. Asparagus should be gathered when the shoots are 8 to 10 inches long, before the tough fibers develop.

Root crops should be gathered when they are of moderate size. When too old they become woody and sometimes of poor flavor. Potatoes may be harvested for immediate use any time after they have reached a fair size, but should be allowed to mature fully, as shown by the death of the vines, if they are to be stored.

Green onions, rhubarb, kohl-rabi, parsley, leaf lettuce, cress, spinach, New Zealand spinach, chard, kale, mustard, and collards may be harvested as soon as the edible parts reach a fair size. Many of these, if allowed to mature more fully, go to seed and become of little edible value.

Onions for storage should be fully mature. Maturity is indicated by a breaking over of the leaves just above the bulb. Head lettuce, cab-

bage, and Brussels sprouts should be harvested when the heads become firm and compact. Tomatoes and eggplants are best when the fruits have reached a uniform color, red or yellow in tomatoes, purple in eggplants. Cucumbers for pickles may be harvested at any time, according to the kind of pickles to be made. For slicing they should be gathered just before the seeds begin to get hard. Peppers may be picked at any time depending upon the use to be made of them. Summer squash should be used when immature. Winter squash and pumpkins should be allowed to mature fully on the vine. Muskmelons that separate easily from the vine are ready for use.

Cabbage and celery will stand light frosts, but should be harvested before severe weather sets in. Kale is better after it has been touched by frost. Parsnips and salsify may be left in the ground all winter and used in the spring. Peas, beans, or Lima beans that mature on the vines may be stored and used in the winter.

VEGETABLES FOR WINTER USE

The storage of vegetables is quicker, cheaper, and easier than canning or drying, when possible, and is the only method of keeping certain vegetables not adapted to canning or drying. But storing must be done properly.

Planting time for storage vegetables.—Vegetables should be at the proper stage of development at the time of storage to give the best results. They should reach maturity as late in the season as possible and yet should avoid injury by cold weather. This necessitates planting at different dates if some are for storage and some for immediate consumption. An early maturing variety should be planted later than a late maturing one. The shorter the growing season, the earlier the planting should be made. The more favorable the growing conditions, such as moisture, temperature, soil fertility, etc., the later one can plant.

A circular on vegetable storage, giving detailed information on storage requirements of different vegetables and directions for arranging storage space in basements and for making storage cellars and outdoor pits, may be had by writing the Bulletin Office, University Farm, St. Paul.

COMMON INSECT PESTS OF THE VEGETABLE GARDEN[1]

Attack the insects early! Destroy them before they destroy the plants! Insects not only cause a great loss by the mechanical destruc-

[1] Prepared with the aid and criticism of A. G. Ruggles, Professor of Entomology and Economic Zoology, University of Minnesota.

tion of plant parts but they are often carriers of diseases that may cause greater injury than the insects themselves. The control of insects and diseases is just as essential to efficient vegetable production as any other cultural operation.

Insects may be divided into two classes according to the way they feed:

1. Insects that suck the juices from the plant tissues. Some of the more important of these, from a vegetable grower's point of view, are aphids (plant lice), thrips, leaf hoppers, and the squash bug. They are controlled by the use of contact poisons, such as nicotine sulphate, pyrethrum extracts, miscible oils, or derrisol.

2. Chewing or biting insects. These must be controlled, altho not all can be destroyed, with stomach poisons, such as calcium arsenate, lead arsenate, paris green, or hellebore. Among the more important of these vegetable pests are the cabbage worm, cucumber beetle, onion maggot, asparagus beetle, cabbage maggot, flea beetle, cut worm, Colorado beetle (potato bug), white grub, wireworm, corn-ear worm, grasshopper, and tomato worm.

Arsenical poisons and nicotine extracts are poisonous to man as well as insects. For this reason, such poisons as pyrethrum and derris compounds, that are relatively non-poisonous to man or birds, should be used on plants on which the poison comes in contact with an edible part that is not removed before eating. These include the leafy crops, tomatoes eaten without peeling, snap beans, sugar peas, beets used for greens, and other crops of a like nature. Greens and salad crops should never be treated with arsenicals or nicotine extracts (except free nicotine) in the home garden. Crops of which the fruit is the edible part may, for the sake of economy in spraying, be treated with these poisons until the fruiting parts form. After the fruits form, the insecticides non-poisonous to man should be used.

The various poisons are applied either as dusts or sprays, and the plants should be well covered. Use arsenical and copper sulphate dusts during calm weather, if possible, and when the dew is on the plants. Nicotine dusts, when used alone, should be applied during the heat of the day. Sulphur dusts should be applied when the plant is dry.

Cultural Practices Help

In addition to the use of insecticides, good cultural practices will do much to aid in insect and disease control. Frequent cultivation, elimination of weeds, and plenty of water and fertility tend to produce strong, rapidly growing plants that are more resistant to insects and diseases than weaker plants. Fall plowing causes the destruction of many larvae and eggs. When a crop is harvested, remove the debris and burn, especially if destructive insects or diseases have been present during the growing season. This destroys many insects, larvae, and

eggs, and also materials which provide a favorable breeding, hiding, and over-wintering place for them. Crop rotation and the changing of the location of the garden, where it is possible, also aid in the control.

Cutworms.—Cutworms early in the spring attack many vegetables and cut off the stems near or at the surface of the ground. They are particularly destructive to young transplants. The following mixture has been found to be effective in their control:

Bran	1 quart
Paris Green	1 teaspoonful
Molasses	¼ teacup
Water	Just enough to moisten

Broadcast this, thoroly mixed but moist, around the plants, late in the evening. The insects feed at night. When transplanting, place a ring of the mixture around the plant, about one inch from it. Army worms may be controlled by the same treatment. Grasshoppers feed during the day. The same treatment is effective in their control, but it should be applied in the morning.

Another method, sometimes used with transplants to prevent cutworm injury, is to wrap the stems, from the roots to the first leaves, with paper at the time of transplanting.

Cabbage maggot.—The cabbage maggot bores into the larger roots and lower parts of the stem. When plants wilt badly during the heat of the day in June, this type of injury is indicated altho certain diseases cause a similar effect. The worm attacks cabbage, cauliflower, turnips, radishes and other related crops. To control, dissolve one ounce of corrosive sublimate in warm water in a *wooden* or *crockery* container (metal containers must not be used), and dilute with water to a 10-gallon solution. Be sure the corrosive sublimate is completely dissolved. Water each cabbage plant with about ½ cup of the solution, 3 to 5 days after setting, and give two more treatments at 10-day intervals. For radishes, water along the row at the time the bulb starts to form. One treatment often serves the purpose for radish, but it is sometimes advisable to treat them a second time in about a week.

Aphids.—Aphids (plant lice) multiply very rapidly in warm weather, and attack most vegetable crops to some extent. They are particularly bad on cabbage and related crops and on peas. Infested plants should be treated just as soon as they appear.

1. Spray thoroly with a solution of 1 gallon of water, 1¼ teaspoons of 40 per cent nicotine sulphate, and one ounce of soap, just as soon as the insects appear and about every 7 to 10 days thereafter.
2. Dusting with a mixture containing 5 per cent nicotine sulphate is sometimes used. It should be done in the heat of the day.
3. Pyrethrum sprays (Evergreen) are also good but are more expensive.
4. Destroy all refuse in the fall.

Cabbage worms.—Cabbage worms eat the leaves of the plant and often make the whole head unusable. They may be controlled by spraying with 2 pounds of calcium or lead arsenate to 50 gallons of water, just as soon as the worms appear. Give later applications if necessary. By adding ½ pint of nicotine sulphate to this solution, cabbage worms and aphids may be controlled at the same time. When the plants are approaching maturity, use pyrethrum or derris compounds to avoid any possible danger of poisoning the plant for food.

Leaf hopper.—Leaf hoppers, small insects that may be identified by their peculiar method of jumping sideways, may attack beans, beets, celery, dill, peas, and other crops, and are particularly harmful to potatoes.

1. Spray with a solution of 4 pounds copper sulphate, 5 pounds hydrated lime, and 50 gallons of water. This is a Bordeaux mixture, the method of preparation of which may be obtained upon request from the Bulletin Office, University Farm, St. Paul. This should be applied at a pressure of 200 pounds, where possible.
2. Use a copper-lime dust containing 25 per cent monohydrated copper sulphate (difficult to obtain). This, if applied thoroly when there is plenty of dew on the plants, should give results very similar to those of the spray.

Thrips.—Thrips are very small insects, difficult to see. Their presence is indicated by whitish blotches that show plainly on a leaf on which they have been feeding. A plant may become so badly infested that it becomes entirely bleached, dries from the top down, and dies. Thrips attack cabbages, beans, peas, etc., and are particularly destructive to onions. Their control is difficult, but the following methods will aid somewhat:

1. Spray as for aphids.
2. Dust as for aphids.
3. Plow in the fall, plant early, destroy refuse, and avoid planting near weed-infested areas or areas in which winter onions are growing.

Cucumber beetle.—The striped cucumber beetle, feeding on the vine crops, often kills young plants and causes serious damage to older plants. It also spreads bacterial wilt and cucumber mosaic diseases which may be very destructive, particularly to cucumbers. Control measures must be thoro. Control by dusting the plants, especially under the leaves, with a mixture of 1 pound of calcium arsenate to 19 pounds of gypsum. Burned gypsum is most satisfactory. This should be thoroly mixed by rubbing through a fine screen several times, and applied as soon as the plants appear above ground. The plants should be kept covered with the mixture as long as beetles are present. In the home garden, the young plants are sometimes protected by screening. All refuse should be destroyed.

Squash bug.—The squash bug, often called "stink bug," because of its offensive odor, is destructive on squash and pumpkins in particular, and is difficult to control. It is usually of no importance north of the twin cities. It is a sucking insect, and must be killed by a contact poison. Sprays strong enough to kill the adults, injure the plants. The young nymphs may be killed by spraying the stems and under sides of the leaves with a solution of one fluid ounce of 40 per cent nicotine sulphate to 3 gallons of soapy water. The mature bugs collect under old boards and can be killed by collecting from under such boards early in the morning and by dropping them in kerosene. After the squash crop is harvested, refuse should be burned.

Asparagus beetle.—Asparagus beetles injure the edible product by eating holes or by depositing eggs on the spears, and by defoliating the older plants. Keeping the bed clean during the cutting season avoids the injury to a considerable extent. Cutting beds may be sprayed with non-poisonous pyrethrum compounds. Spray any plants left to grow during the cutting season, and all plants after the cutting season, with a solution of 2 pounds calcium or lead arsenate, 3 pounds soap, and 50 gallons of water. Keeping plants thoroly covered with a dust mixture of 1 part calcium arsenate to 19 parts hydrated lime, is also effective.

Colorado potato beetle.—The potato bug, besides being a pest on potatoes, often attacks tomatoes, and sometimes completely defoliates eggplants. Spray the plants with a solution of 4 pounds stone lime or 6 pounds hydrated lime, 4 pounds copper sulphate, and 50 gallons of water, plus 1½ pounds calcium or lead arsenate. Apply just before, or as soon as, the eggs hatch. The young bugs do the greatest damage. The blister beetle, sometimes called "old-fashioned potato bug," is controlled by the same treatment. Dusting with a mixture of 1 pound calcium or lead arsenate and 19 pounds of hydrated lime is also effective.

Corn-ear worms.—In many years in Minnesota corn-ear worm moths lay their eggs on the silks of corn, and the larvae eat their way into the ears where they destroy the kernels. In the home garden, they can be controlled fairly effectively by dusting the silks with a mixture of 3 parts of arsenate of lead to 1 part of flowers of sulphur, *just as soon as the silks appear.* Repeat at 3- to 5-day intervals during the ear-forming period.

Additional information on control of garden pests may be had by writing the Bulletin Office, Unversity Farm, St. Paul, for Folder 32, "Vegetable Garden Insects and Their Control," and Circular 17, "Grasshopper Control."

COMMON DISEASES OF GARDEN VEGETABLES

By J. G. LEACH[2]

Very few plant diseases can be cured after they once appear in a crop. Plant disease control is largely a matter of prevention and any control measure to be effective must be started early, before the disease becomes established. Often the control measures must be applied before the seed is planted and sometimes even earlier.

The following is a short description of the most common diseases of garden vegetables in Minnesota, with brief directions for their control:

Asparagus

Rust.—Rust is the only disease that ever causes much damage on asparagus in Minnesota, and, since the growth of the rust-resistant varieties has become general, the disease has become rare. On susceptible varieties, the typical red rust pustules may develop abundantly on all the above-ground parts and so weaken them that the yield of sprouts the following season will be greatly decreased. The rust fungus lives over winter on the old stalks and is ready to infect the new sprouts when they are permitted to grow. Careful collection and burning of old stalks in the fall will tend to reduce the amount of rust. The best control measure, however, is to grow rust-proof varieties such as the Mary or Martha Washington.

Beans

Anthracnose.—Anthracnose or pod-spot is a common disease of beans, but is destructive only in seasons with abundant rainfall. It may be recognized by the brown sunken spots, with pink sticky masses of spores, on the pods. The disease is caused by a fungus that lives from year to year in infected seed. The best control measure is to select enough healthy pods, with no spots, to furnish seed for the next year's crop. It is absolutely necessary to select healthy pods, because infected seeds after they are threshed cannot be detected. Because the fungus may survive for a short time on the dead stalks, it is desirable to avoid growing beans on the same soil two years in succession. If beans are cultivated or picked while the plants are wet, the disease will be spread from plant to plant.

Bacterial blight.—Several bacterial diseases of beans, more or less similar in nature, are prevalent in Minnesota every year and often do a great deal of damage. All cause spotting and dying of the leaves and blemishes on the pods. On affected pods the blights are sometimes

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confused with anthracnose. The spots caused by the bacterial blights are not sunken like those caused by anthracnose, and they are less regular in outline. A yellow or translucent area is often present about the water-soaked blotches caused by the bacterial diseases. The bacteria causing these diseases are also carried over in infected seed. The only practical control measure consists in planting disease-free seed. Such seed may be obtained by pod selection as recommended in the control of anthracnose. Crop rotation should be practiced and the plants should not be cultivated when they are wet.

Mosaic.—Mosaic, a common and often destructive disease of beans in Minnesota, causes small stunted plants, with pale green, mottled leaves, which set very little fruit. It is a virus disease spread from plant to plant by plant lice and is also seed-transmitted. Careful seed selection from healthy plants will give practical control. Two varieties of garden beans highly resistant to mosaic have been introduced recently. These are the Wisconsin Refugee and the Idaho Refugee. One variety of the white pea-bean type, namely Michigan Robust, is resistant to mosaic. Where these varieties meet the needs of the grower, mosaic need not be a factor.

Rust.—Rust, tho often present on beans in Minnesota, is rarely very destructive. Brown rust pustules are found on leaves, stems, and pods, and may reduce the yield of marketable pods. The rust fungus lives over winter on the dead plants, and control depends on the effective control and burning of all old plants in the fall and on the rotation of crops.

Cabbage

Black-rot.—Black-rot is one of the most common diseases of cabbage in Minnesota. It is caused by bacteria that are carried in the seed and that may also live over winter in the soil of the seed bed. Plants affected with black-rot are stunted, and the leaves turn yellow and fall off. Badly affected plants may be killed in the seedling stage. Some lightly affected plants may survive, but they will rarely form marketable heads.

Black-rot is difficult to control, and seed treatment is advised. The most practical seed treatment for the grower is the mercuric chloride. Using mercuric chloride tablets that may be obtained from any drug store, make up a solution of 1-1000 strength. Tie the seed in a loose cheesecloth bag and immerse in the solution for 30 minutes, taking care to expel all of the air from the bag so that all of the seed will get wet. Then remove the bag of seed and rinse thoroly in clean water. Spread the seed out in a warm place and let them dry. They are then ready for planting.

Since bacteria may survive in the seed-bed soil, it is advisable to use clean soil as often as possible, or to sterilize the seed-bed soil before it is used for cabbage a second time.

Under moist conditions black-rot will spread rapidly from plant to plant in the seed bed, altho the infected plants will not show symptoms until they are planted in the field. It is, therefore, advisable to give the plants as much ventilation as possible in the seed bed, so that drops of moisture will not stand on the surface of the plants. Watering the seedlings at frequent intervals with a solution of Semesan according to directions on the container is also recommended.

Different lots of seed vary greatly as to the amount of black-rot infection. A survey has shown that seed grown in arid, irrigated regions such as the Skagit Valley of Washington State are less likely to be infected than those grown in regions of heavier rainfall. Whenever possible, seed from this region should be obtained.

Yellows or cabbage wilt.—Yellows, or cabbage wilt, has become very prevalent in Minnesota during the last three hot and dry summers. The disease, often confused with black-rot, is caused by a fungus that lives from year to year in the soil. It is not transmitted in the seed. Plants affected with yellows are stunted, the leaves turn yellow and drop off, and the plants often die before a head is formed. The only control measure is to grow the yellows-resistant varieties. A half dozen or more varieties including early, mid-season, and late types are available and are handled by most seed dealers. These varieties will give a good crop on infected soil where the old varieties will be a complete failure. Where yellows has once made its appearance only the resistant varieties should be grown.

Blackleg.—Blackleg is caused by a seed-borne fungus that may also live over winter in the seed bed. The fungus attacks the roots and the lower parts of the stem, causing a dry rot, and may also cause spotting of the leaves. Seed treatment and the use of clean soil in the seed beds as recommended for the control of cabbage black-rot are advised. Watering with Semesan and ample ventilation of the beds is also recommended.

Club-root.—Club-root, rapidly becoming established in Minnesota, is caused by a slime mold that lives from year to year in the soil, thrives best in a low moist soil, and is often found in low places in a field while the higher ground remains free. It causes large swellings on the roots, resulting in stunted growth and small worthless heads. Affected roots are often decayed by a bacterial rot in mid-season, causing the death of the plant. It is spread by cultivating tools or on the feet of animals and may be introduced into new localities by planting

infected seedlings. For this reason, it is recommended that, if possible, a grower should produce his own plants from seed. Infected seedlings can not always be detected by examination. If any root swellings indicating club-root are found in a lot of seedlings, it would be unwise to plant any of the seedlings, altho they might show no symptoms at the time.

Where club-root has become established in the soil, heavy losses may be avoided by applying hydrated lime to the infected soil at the rate of 25 pounds per square rod, and by rotating crops so as to avoid growing cabbage or other cruciferous crops on the affected soil for several years.

Celery

Late blight.—Late blight is the most common and destructive disease of celery in Minnesota. It is caused by a fungus that is often carried in and on the seed, but that also commonly survives in the remains of celery plants in the field and seed bed. The disease is favored by rainy weather but may be destructive in dry weather if overhead irrigation is extensively used. It can be controlled effectively by spraying with Bordeaux mixture or dusting with copper-lime dust. Two or three applications must be made in the seed bed while the plants are very small, followed by four or five in the field.

Yellows.—Yellows is a fungus disease. It stunts the plants and causes them to turn yellow early in the season. Often the crown will be internally rotted with a brick-red decay. The fungus lives in the soil, and once the soil is infected, it is always "celery sick." The green varieties are resistant and will produce a good crop. The Michigan Agricultural Experiment Station has recently introduced a new variety, known as Michigan Golden, highly resistant to yellows. This variety was tested on a small scale in Minnesota in 1934, and was found to be highly satisfactory. Celery growers who have had trouble with celery yellows should get seed of this variety and grow it exclusively. Growers who do not have yellows in their fields should never buy plants but should always grow their own.

Cucurbits (Cucumbers, Muskmelons, Squash, etc.)

Mosaic.—Mosaic of cucurbits, the most destructive disease of cucumbers, is also common on other cucurbits, and affects many weeds. It is a so-called virus disease and is very difficult to control. It is rarely seed-transmitted, but commonly survives the winter in the roots of infected perennial weeds. In the spring it is spread by insects from the new growth on weeds to the young cucurbits. It stunts the plants, and gives the leaves a mottled appearance, with light and dark green areas,

especially notable at the tips of the new growth. Older leaves may turn brown and dry up. The fruits are small and distorted.

The disease is very difficult to control. Where cucurbits are grown intensively, the perennial weeds become infected and the disease is very prevalent. Cucurbits grown in isolated places are seldom affected. The eradication of all perennial weeds such as milkweed and nightshade, as well as the annual wild cucumber in the vicinity of cucumber fields, is said to give good results.

Bacterial wilt.—Bacterial wilt, common on cucurbits in Minnesota, causes a slow wilting of the plants. The bacteria live in the water-conducting vessels of the stem and cut off its water supply. They enter the plant through the feeding wounds made by cucumber beetles. The beetles constitute the only known means of spreading the disease. The bacteria also survive the winter in the bodies of the over-wintering insects. For these reasons the only control of the disease lies in the control of the cucumber beetle. This is best accomplished by dusting the young plants with a mixture of 1 part calcium arsenate to 19 parts of gypsum. The plants should be kept well covered with dust until the runners are several feet long.

Anthracnose.—Anthracnose is common on cucurbits in wet years or when overhead irrigation is used excessively. It is caused by a fungus that forms small spots on the leaf veins and larger brown sunken spots with pink centers on the fruit. Where the disease is present, it is advisable to avoid overhead irrigation, and to spray the plants at frequent intervals with bordeaux mixture. The fungus spores are often carried on the seed, so that seed should be disinfected with a mercuric chloride solution. The seed are soaked for ten minutes in a solution of mercuric chloride (1 to 1000), then washed in clean water, and spread out to dry.

Muskmelon wilt.—Muskmelon wilt is a destructive fungus disease, known only in Minnesota. It was first observed in 1931 in Hennepin County, where a loss as high as 90 per cent was caused in several large fields. Observations since 1931 show that it is slowly spreading. The fungus lives indefinitely in the soil and may kill muskmelon plants at any stage of growth from seedling to mature plants. Affected plants wilt and die within a few days, and often show long brown streaks along the stem in the early stages. The disease affects muskmelons only, and may be introduced into new fields by infected dirt adhering to tools or the feet of animals, or may be introduced on seed from infected fruits. Seed should be treated as recommended for anthracnose as a precaution against introduction of the disease on the seed. Attempts are being made to select wilt-resistant varieties, but none are yet available.

Peas

Root rot.—Root rot is the most common disease of garden peas. It is caused by several different fungi that live in the soil. The fungi attack the roots most readily when the soil is excessively wet. Continued growth of peas on the same soil favors the development of root rot. Rotation of crops and the planting of peas in the better-drained soils are the only control measures recommended.

Wilt.—Wilt of peas, common in Minnesota, resembles root rot in some respects, but it is caused by different fungi. Some varieties of peas are more resistant to wilt than others, and where wilt is present in the soil much loss may be prevented by growing the more resistant varieties. Of the varieties commonly grown in Minnesota, Early Dwarf Telephone, Alderman, Potlatch, Melting Sugar, and Giant Butter are said to be most resistant.

Sweet Corn

Seedling blight.—Seedling blight is troublesome in sweet corn when the seed must germinate in cold wet soil. It is caused by several different fungi that commonly live in the soil but may also be carried in infected seed. These fungi are ordinarily able to injure the seedling only when it is growing in soil that is too wet and cold. Experiments have shown that dusting the seed with Semesan Jr., at the rate of 2 to 3 ounces to each bushel of seed, will protect the seed during the critical period, and greatly increase the stands in unfavorable weather. The cost of the treatment is very small, and all sweet-corn seed should be dusted before planting.

Smut.—Smut, a very destructive disease of sweet corn, is difficult to control. Applications of barnyard manure before planting sweet corn are especially conducive to smut. The smut fungus will grow in the manure and produce millions of spores that infect the young corn plants. The common practice of removing smutted stalks and feeding them to livestock should be discouraged. Such stalks should be removed and burned as soon as the smut is evident. A new variety produced by the Minnesota Agricultural Experiment Station, known as Minhybrid 202, is more resistant to smut than the older varieties.

Tomatoes

Blossom-end rot.—Blossom-end rot, one of the most common diseases of tomatoes in Minnesota, is a non-parasitic disease. The fruit decays at the blossom end or point. The disease is caused by excessive transpiration or loss of water following abrupt changes from moist to dry weather. It is worse in light soils of poor water-holding capacity,

or in clay soils that tend to bake, and is induced by excessive fertilization with nitrogen. In dry seasons, the periodic applications of water, permitting wide fluctuations in the water supply, greatly increase blossom-end rot. Good cultivation and the maintenance of a uniform soil moisture are the only practical control measures.

Leaf spot.—Leaf spot is a fungus trouble, prevalent in rainy weather only. It rarely causes much damage. When it is very prevalent it may be advisable to spray several times with Bordeaux mixture.

Mosaic.—Mosaic, common on tomatoes, causes a mottled and light green color of the leaves and often stunts the plants and reduces the yield. It may be spread from plant to plant by sucking insects and also by man while cultivating or pruning the plants. It may affect many other plants, including wild perennial weeds. It is thought to live over winter in the roots of such plants. Eradication of all perennial weeds in the vicinity of tomato fields and seed beds is recommended. The early recognition of the disease and the removal of affected plants will often prevent its spread.

Miscellaneous Seedlings

Damping-off.—Damping-off is a destructive fungus disease affecting all kinds of herbaceous seedlings. The fungi live in the soil and cause a rot of the young stems at the ground line. Affected plants wilt, fall flat on the ground, and then die and dry up. The disease is favored by wet soil and high humidity, also by insufficient sunlight and poor ventilation. The use of new seed-bed soil, or complete soil sterilization by heat, steam, or formaldehyde, is recommended, when such measures are practicable. A formaldehyde dust, now on the market, gives very good results, when it is mixed with the soil just before the seeds are planted, and should be used as directed by the manufacturer. Damping-off of many kinds of seedlings may be controlled to some extent by watering the plants in the seed bed with a solution of Semesan. Good ventilation should be provided and excessive watering should be avoided. The crowding of seedlings interferes with ventilation, and should be avoided.

Potato disease control is dealt with in two publications available from the Bulletin Office, University Farm, St. Paul: Special Bulletin 144, "Blackleg of Potatoes," and Folder 29, "Acid-Mercury Dip, A Simplified Treatment for Seed Potatoes."

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